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No. 73

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ICI ANNOUNCES DISCOVERY OF BIOTECHNOLOGICAL POLYMER

Paris INFORMATIONS CHIMIE in French May 81 p 123

[Article: "ICI: Biotechnological Thermoplastic"]

[Text] Dr Peter King, director of the Agriculture Division of ICI, at the second European Conference on Biotechnology in Eastbourne, announced the discovery of a revolutionary polymer manufactured using a biotechnological process; the polymer is a polyester, poly-2-hydroxybutyrate (PHB).

Glucose from corn is converted into the polymer by a bacterium, Alcaligenes eutrophus, of which PHB constitute 80 percent of the cellular mass. With this bacterium it is possible to obtain a PHB whose physical properties do not vary with the substrate.

According to Dr King, the U.S. company W. R. Grace had already worked on a type of PHB produced by microorganisms, but the originality of the ICI process rests with the method used for separation and purification of the polymer.

The product obtained, $(CH(CH_3)CH_2COO)_n$, where n is between 5,000 and 10,000, is a high molecular weight thermoplastic whose stereoregularity offers some attractive features. It can be plasticized and oriented or reinforced with glass fibers, and it is biodegradable in the soil. It is more dense than polypropylene (1.25 versus 0.905), and its glass transition temperature is higher, but it is less resistant to solvents; on the other hand, it is more resistant to UV.
ICI presently produces 10 kg of this product per week, which is far from competing with the petroleum-derived polymers, but nevertheless the product is a fascinating example of the possibilities of biotechnology.

Properties of PHB and Polypropylene Compared

Properties	Units	PHB	PP
Melting point	°C	175	176
Crystallinity	%	80	70
Molecular weight	daltons	5×10^5	2×10^5
Glass transition temperature	°C	15	-10
Density	g/cm^3	1.250	0.905
Flexural modulus	GPa	4.0	1.7
Tensile strength	MPa	40	38
Elongation at break	%	6	400
UV resistance		good	poor
Resistance to solvents		poor	good

9828
CSO: 3102/378

HIGH-TECHNOLOGY ALTERNATE ENERGY PROJECTS USE NEW MATERIALS

Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 7 Jul 81 p 1

[Article by Hellmut Droscha: "Wind and Sun as Primary Energy"]

[Text] Frankfurt, 6 Jul--Fiber composites have found acceptance in power engineering as well. For example, a high-voltage transformer has been provided with a puncture-proof cover made of glass-fiber reinforced plastic, and a wind-tunnel fan has been given rotor blades designed according to the "sandwich construction" out of glass-fiber and carbon-fiber reinforced plastic layers (MBB [Messerschmitt-Boelkow-Blohm GmbH]).

And recently work was completed on the prototype of a "large wind-energy facility" [Grosse Windenergie-Anlage]--named "Growian" for short--which is being erected in Brunsbuettel. Its two rotor blades, 50 meters in length, have a steel spar structure with an external contouring done with long-fiber composite plastics, which increases strength. For the tip of the blade in each case, carbon-fiber reinforced plastic was chosen, and for the remainder--that is, the main part--glass-fiber reinforced plastic was selected (M.A.N. [Augsburg-Nuernberg Machine Factory, Inc.]). This facility is designed for a power-generation capacity of 3,000 kilowatts. It consists of a tower 100 meters high, at the top of which the two-bladed rotor turns around its horizontal axis. Moreover, the rotor bearing arrangement located within the tower top, together with all the mechanical equipment, is also pivoted about the vertical, so that the rotor can always be "turned into the wind" in the manner of a windmill. This rotor drives two electric generators by way of the interconnection of a high-transmission gear unit. These generators produce their maximum power at a wind velocity of 12 meters per second. In the interior of the tubular steel tower, a passenger elevator is installed.

An alternative to this system of a wind-energy converter with a horizontal rotational axis and a two-bladed rotor similar to a gigantic propeller has been developed by another party. In this new system (Dornier), the rotational axis is vertical and is constructed like a tubular or lattice-type tower. Moreover, the three rotor blades have nothing in common with a propeller, but call to mind an archery bow, which here (with the omission of the stretched string) is fastened always to an upper and a lower point on the axis of rotation. The symmetrically curved shape of the three "bow blades," which are positioned at angular spacings of 120 degrees in each case around the axis of rotation, catches the wind with its concave side, while this wind flows off on the convex side--similar to what happens also with the hollow-sphere shells of the familiar wind-measuring instruments. Serving as an aid to starting are two mini-rotors installed around and close to the axis of rotation, which have a basically cylindrical shape and which are reminiscent of the Flettner ventilators in the ceilings of former buses.

Thus this facility, with its markedly simple structure--which for now is being built with small dimensions--is able to dispense with all external power sources, and since it is independent of wind direction it never needs to be shifted around. Also its maintenance needs are small. Its basement is the location for the easily accessible utilization unit, which can be either an electric generator or a pump for delivering drinking water from a well or for irrigating relatively small agricultural areas.

The bow blades of the main rotor are manufactured in one piece from an extruded aluminum alloy, but they can also be fabricated from other material which may be available at the site. One small prototype design with a rotor diameter of 5 1/2 meters and a power of 4 kilowatts at a wind velocity of 10 meters per second is in operation both on the North Sea island of Pellworm and on the Black Forest mountain of Schauinsland. On the very windy Atlantic coast of Patagonia in the southern part of Argentina, already a somewhat larger facility with a rotor diameter of 12 meters is furnishing a power of 20 kilowatts.

Still in the early stages of development is a technique on the basis of which solar radiation can be converted directly--that is, under a blue sky, or as diffuse light with an overcast sky--into heat or into electric power. In fact, this is done without any additional devices such as mirrors or lenses, by means of a transparent medium which serves as the collector--for example, plexiglass--in which a fluorescent pigment is embedded. That is to say, this pigment absorbs incident light within a certain spectral range and radiates light of somewhat longer wavelengths as fluorescence. Because of the total reflection involved, as the physicists explain (Work Group for Solar Energy Systems of the Fraunhofer Society), a large portion of the generated light is guided along within the transparent plate, at whose ends one can extract it. If it should prove possible to solve all the problems which still stand in the way of an economical output here, then we will be able to obtain solar heating and solar power based on this principle much more cheaply than can be done at present.

With the aid of solar energy, one can also desalinate sea water and convert it to drinking water. In La Paz, capital of the Mexican territory of Baja California Sur, a relevant small facility has come into being (Dornier, M.A.N., Siemens). By means of the solar heat collected by the total of 680 square meters of solar-collector area, this facility generates 10 cubic meters of drinking water daily out of sea water on the basis of the principle of multistage flash evaporation. Only the electric driving power for the pumps is still provided in the conventional way.

Now of course one must realize that, seen in a world context, facilities of this order of magnitude are only "a drop in the bucket." Because the unremitting growth of the world's population and the rising standard of living with increasing industrialization are leading inevitably to the situation where the earth's fresh-water reserves are being drawn on more and more, and because of this they are either approaching depletion or else their salt levels are rising.

12114
CSO: 3102/356

ENERGY

SWEDISH CONSORTIUM PLANS SYNTHETIC FUEL PLANT

Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 23 Jul 81 p 7

[Text] The three Swedish companies Asea, Nynaes Petroleum and Stoseb, the communal energy-generating concerns of greater Stockholm, have agreed on the formation of a consortium to propose a plant to produce synthetic fuels. This proposed plant is to be built in Nynaeshamm, about 30 kilometers southeast of Stockholm and to be put into operation in 1987/88. The total cost is estimated at $400 to $500 million. It is calculated that the amount of fuel produced will be sufficient to meet one-tenth of the gasoline consumption in Sweden. In addition to fuel, hot water can also be produced for the district heating supply of Stockholm, as well as synthetic heating gas. Sweden's crude oil imports might be reduced in this way by about 1 million tons, the companies believe.

The basic materials will be principally coal and heavy oil. Gaseous and liquid fuels (methanol or synthetic gasoline) can be obtained through gasification and synthesis. The low-grade effluent heat from this process is to be utilized for district heating. In contrast to traditional gasification of coal or the burning of heavy oil for heating gas and hot water generation, there would be only low levels of emissions in the proposed plant. Pollution from sulfur dioxide, for example, would be reduced by 10,000 tons annually.

Energy consumption could be reduced still further through the use of heat pumps in the district heating network of greater Stockholm. The return water would have a lower temperature before reentering the energy complex. Heat pumps would also be suitable for reclaiming energy from the low-grade effluent heat. About 70 percent of the oil currently used for home heating in Stockholm could be saved by this method.

9581
CSO: 3102/375

RESEARCH MINISTER CALLS FOR EXPANSION OF DISTRICT HEATING

Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 7 Jul 81 p 1

[Article by "K. B.": "District Heating Is To Be Extended"]

[Text] Bonn, 6 Jul--District heating must be greatly expanded. This is what Federal Research Minister von Buelow called for on Monday in Bonn. Von Buelow intends to work toward seeing that district heating is given "a great deal more" consideration in the third updating of the Federal Government's energy program. Notwithstanding all our economizing, governmental support for district heating must not be shortchanged, he said. Its funds must be increased in the new version of the Federal Government-Laender program for the support of energy conservation. Von Buelow does not believe it is nececessary to have a compulsory hook-up and use requirement for people in the vicinity of district-heating grids. As for the controversial district-heating levy, which is still being examined in a study, von Buelow believes that on this question there is "no immediate need for action" at the present time. He said that the crucial prerequisite for the expansion of district heating networks is cohesive local and regional supply plans.

Such a plan for supplying the Ruhr has now been proposed by the Association of Ruhr Communities to the Federal research minister and to the Land of North Rhine-Westphalia. An overall plan is to be prepared at a "Ruhr district-heating conference" by all enterprises which have a share in the district-heating market in this area. The director of the communities' association, Juergen Gramke, gives assurances that the heating-supply market mechanism is to be limited as little as possible by this plan. He said that it must be realized in a businesslike way and must be calculated in terms of managerial economics. On the other hand, he said, we should put an end to the situation where the private and municipal enterprises obstruct one another in the heating market.

In the opinion of the research minister, the expansion of district heating is a necessary economic and political decision, because thereby the energy reserves, the environment, and foreign exchange could all be conserved at one blow. Some 20 to 25 million tons of hard-coal units could be saved annually through district heating. Its share in the district-heating market [sic] could rise to at least 25 to 30 percent in the next 10 to 15 years. This changeover in the heating market takes time. It would be unrealistic to expect extensive changes in a few years.

12114
CSO: 3102/356

FRAUNHOFER WORKS TO DEVELOP, IMPROVE SEEING ROBOTS

Duesseldorf HANDELSBLATT in German 22 Jul 81 p 20

[Article by Uwe Ahrens: "Robots Getting Better and Better at Recognizing Parts"]

> [Text] The small number of industrial robots in use in comparison to the large number of manipulation tasks which are still manually executed can be explained on the basis of economics and the sensory deficiencies of industrial robots.

The human being, with the aid of his sensory organs, can iterate manipulations in such a way as to satisfy 1,020 different boundary conditions. A sensory faculty for industrial robots can make possible a connection between the environment and a programed work process which will yield a coordinated behavior adapted to the situation.

An important task of automatic manipulation, in addition to parts identification, is the determination of location and angular orientation of partially ordered parts as a precondition for grasping by an industrial robot.

Under certain boundary conditions related to the field of application, this task can be accomplished with the help of video sensors. With the aid of a camera the field of view is converted into electrical signals, partially or totally stored in binary form and evaluated by a wide range of processes depending on the application The results are presented to the industrial robot as a part number and position coordinates.

Such a task-related robot system was recently exhibited at the Hannover Fair by IPA (Fraunhofer Institute for Production Engineering and Automation, Stuttgart). This solution involves the flexible handling of sundry parts presented on a conveyor which is fed by a supply bin. Since it would require a great deal of effort to mechanically preposition the many individaul parts for the robot, a video system coupled with an industrial robot is used in this case. This makes it possible to accommodate the associated constraints, such as touching or overlapping parts, with relatively little outside intervention.

At IPA the current thrust in the sensor area is directed at accomplishing the following objectives:
--Removal of obstacles to practical application of video sensors;

--Development and realization of efficient, standardized interfaces between sensors and industrial robots; and
--Integration of the sensor camera in the robot's gripper.

Because of its central role in applied research, a principal aim at IPA is to bring the number of industrially applied sensors more into line with the number proven under laboratory conditions.

Practical application is hindered by limiting constraints which are determined mainly by the type of object presentation required. With the aid of the projects carried out at IPA, potential solutions are designed and their economics demonstrated.

Unavailable and nonstandard interfaces mean necessary development work for the user and hinder the application of sensors since the necessary access to system software for industrial robots and sensors is not provided. To effect the required transformations of geometric data as well as the coupling between sensors and industrial robots, an additional computer must often be used as an interfacing agent.

IPA is working with other institutes and industrial firms on several committees to generate a recommendation for a standard interface for complex sensors. This recommended practice will specify which interface functions will be assigned to the robot's control system and which to the sensors.

As a rule, the relative position between the part to be gripped and the robot's gripper or between the part and its terminal position will be determined with the video sensor. Difficulties which are expected to be overcome through appropriate research and development work at IPA arise from several sources: camera size; mounting location (visual obscurance by the gripped part); varying observation distance (focusing and scale changing) and varying directions of observation.

The breakthrough in the use of video system can only be expected when grey-tone picture preocessing makes possible the evaluation of randomly presented parts. Reasonable evaluation times will be achieved only through application of new computer structures with array processors which are tailored for parallel picture processing.

9160
CSO: 3102/376

BRIEFS

BMW ORDERS ASEA ROBOTS--The Swedish firm ASEA recently received a contract for 67 IRb 60 industrial robots with a load rating of 60 kp from the Bayerischen Motoren-Werke AG (BMW), Munich. The robots will be used for resistance welding work. [Text] [Essen ELECKTRO-ANZEIGER in German No 10, 1981 p 10] 9160

CSO: 3102/376

SCIENCE POLICY

POWERS OF RESEARCH MINISTRY UNDER DISCUSSION

Paris AFP-SCIENCES in French 18 Jun 81 p 4

[Article: "Powers of the Ministry of Research and Technology"]

[Text] Paris--The Council of Ministers on 17 June approved new authority for the Ministry of Research and Technology, according to sources at the Ministry.

The powers of the Ministry of Research, it seems, are in line with the statements made by the minister, Jean-Pierre Chevenement, on 26 May of this year (see AFP-SCIENCES No 264, 27 May 1981, pp 1-2) when he expressed to the press his desire to rearrange, under the supervisory control of the Ministry of Research, most of the major technological research and development organizations which under the preceding governments were answerable to a number of different ministries, particularly the Ministry of Industry.

If these recommendations are signed by the prime minister and the four ministers involved (research, industry, education, and foreign relations), the Ministry of Research would exercise supervisory authority over five organizations: CNRS [National Center for Scientific Research] (formerly under the Ministry of Universities), the National Agency for Valorization of Research (ANVAR) and the Delegation for Innovation and Technology (formerly under the Ministry of Industry), and finally two organizations, the General Delegation for Scientific and Technical Research (DGRST) and the Interministry Task Force for Scientific and Technical Information (MIDIST), which were already under the supervision of what was then the office of the secretary of state for research [now the Ministry of Research and Technology].

In addition, the Ministry of Research will be provided with three types of jurisdiction over all the other major civil organizations for technological research and development (CNES [National Center for Space Studies], AEC [Atomic Energy Commission], CNEXO [National Center for Exploitation of the Oceans], INRA [National Institute for Agronomical Research], etc.).

The first type of authority is over the preparation and implementation of the budgets of these organizations. In fact this financial oversight represents a return to having a grip on the totality of the "research envelope," about Fr 20 billion in 1981. This "envelope" will no longer be limited to basic research as it was in the past, but will also include the major technological programs (nuclear, space, oceanography, information processing, etc.).

These programs and the organizations which implement them (CNES, CEA, etc.) will still be subject to oversight on the part of their ministry of origin.

The other two types of authority pertain to the power of the Ministry of Research in the matter of organization or reorganization of the major civil research organizations and in the matter of status and use of their personnel.

The people at the Ministry of Research emphasize that in all these domains--financial, personnel policy, and management of organizations--it will act "in liaison" with the other ministries concerned.

9828
CSO: 3102/378

TRANSPORTATION

FRENCH AUTOMAKERS EXPLORE USE OF LIGHTWEIGHT MATERIALS

Paris INDUSTRIES & TECHNIQUES in French 10 May 81 pp 28-32, 34

[Article by Alain Perez: "Steels-Plastics: 'Star of the Show'"]

> [Text] One hundred kilometers on 3 liters of gas. For the future, the automakers' goal is one of austerity. To attain this objective by about 1990, research has been set up on three axes: aerodynamics, engine and transmission component efficiency, and materials; 10 years from now our automobiles will be more finely built, higher in performance, and lighter in weight.

The Renault Eve has an aluminum skin. The Peugeot Vera prefers the composite materials. These latest additions from the French automakers presented at last year's Auto Show are still in the prototype stage. Prepared in haste pursuant to an agreement worked out with the Agency for Energy Economies, these two experimental vehicles, very different in their definition, have now been left behind--more exercises in style and consciousness-raising operations than industrial realities. Nonetheless, the movement is under way.

Today the talk turns to the Vera Plus, Eco 2000, Plume, and Vesta. Concealed behind these acronyms are some very solid plans. Little in the way of spectacular changes is to be expected before 1985. The auto industry's production machinery, jammed before, still moves ponderously.

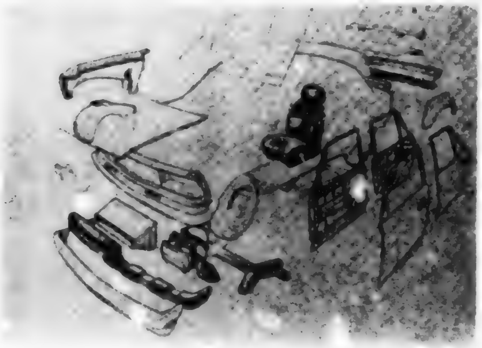
Around 1990, a new generation of low-energy cars will come on the scene, at Peugeot as well as at Renault. The idea is to produce a lower echelon vehicle for mass distribution. Its fuel consumption should approach about 3 liters/100 km in urban driving and about 2 liters/100 km when stabilized at a speed of 90 km/hour. To win this bet, the choice of materials is crucial: 100 kg less mass in motion will mean 0.5 liters less fuel consumption.

Today, there is at least one certainty. The big loser from these changes for which preparations are under way in Rueil [Renault] or in Sochaux [Peugeot] will be cast steel. Even if the foundrymen further refine their crude materials, the handicap of density would appear insurmountable. On the other hand, the models which will appear beginning in 1985 will progressively render obsolete 20 million of the automobiles in service in France. Barring a total breakdown of the system, the costly energy should be a fantastic argument for revitalizing a dormant market.

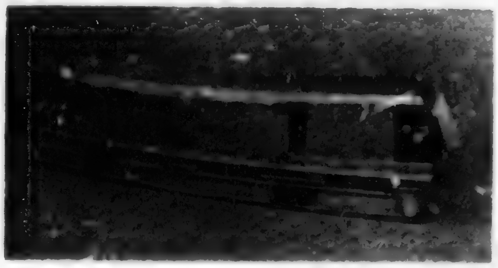
The French automakers do not all have the same approach. At Peugeot, there is a firm belief in the new materials, particularly the reinforced plastic materials. At Renault, the leanings are toward improving the aerodynamics of the body and the efficiency of the drive train. A low rolling inertia is valuable at low speeds; penetration into the air becomes a significant factor beginning at about 90 km/hour. As for the efficiency of the present internal combusion engine (less than 0.3), it is so low in any case that improvements are inevitable.

"For the Eco 2000 project, the efforts begin with a blank page. Anything can be right provided it can be industrialized at a production rate of 1000 per day," remarks G. Sifre. Sifre, of the Peugeot group's very recently formed Directorate of Research and Scientific Affairs (DRAS), is resolutely in favor of the composite materials. "By 1990, it will be possible to fabricate a plastic body in 1 minute."

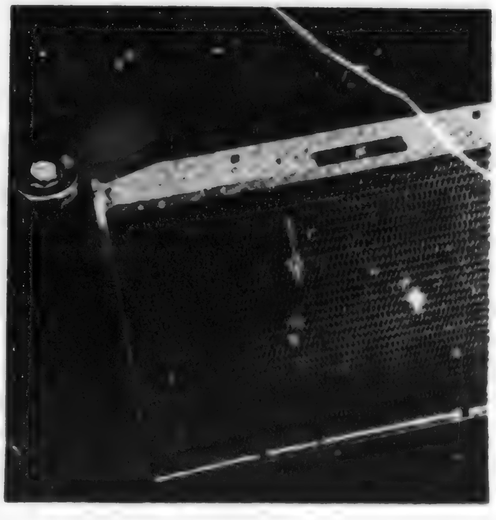
Some figures illustrate the irresistible rise of the plastic materials at Peugeot: 74 kg on the 305, 167 kg on the Vera, 190 kg on the Vera Plus, and 250 kg on the Eco 2000. The reinforced plastics follow a parallel progression in this balance sheet: 1 kg on the 305, 67 kg on the Vera, undoubtedly more than 100 kg on the Eco 2000. The total weight of the vehicle itself follows a descending curve.



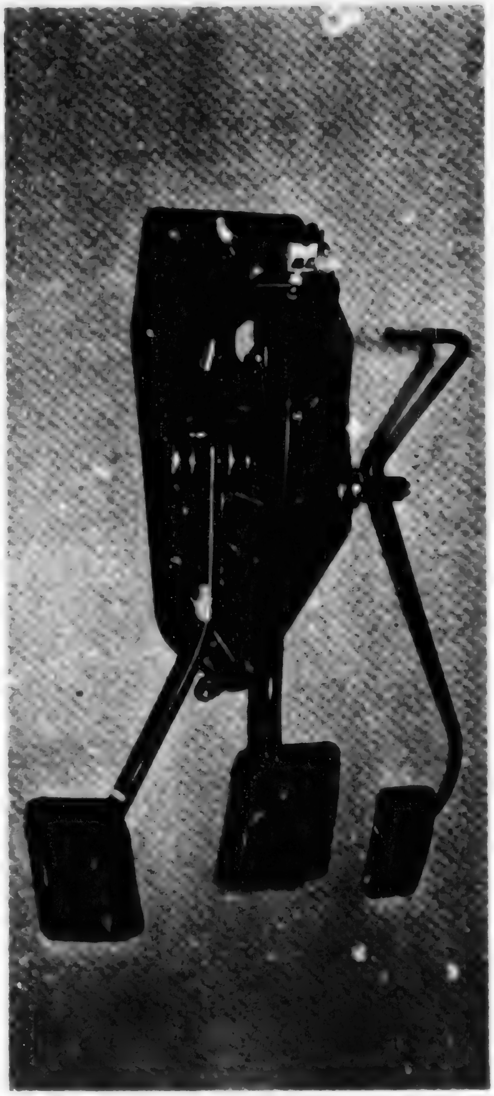
On the Vera prototype, the body frame is made of high-elastic-limit (HCE) steel, and the moving parts are made of composite materials. The overall weight reduction of the body is about 77 kg. (Peugeot file photo)



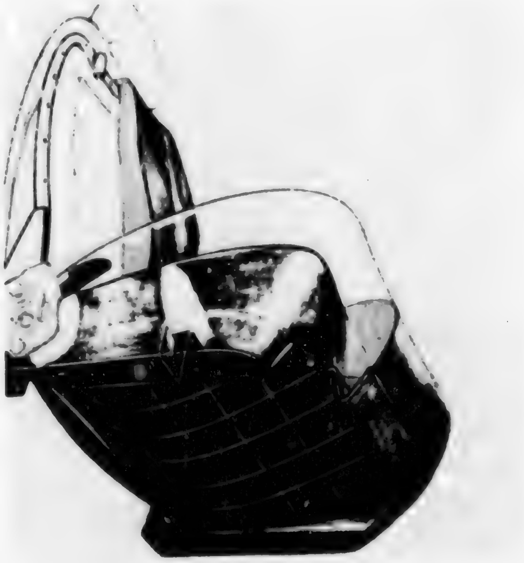
The front frame of the Vera: made with glass-fiber-reinforced polyester and molded SMC. (Peugeot file photo)



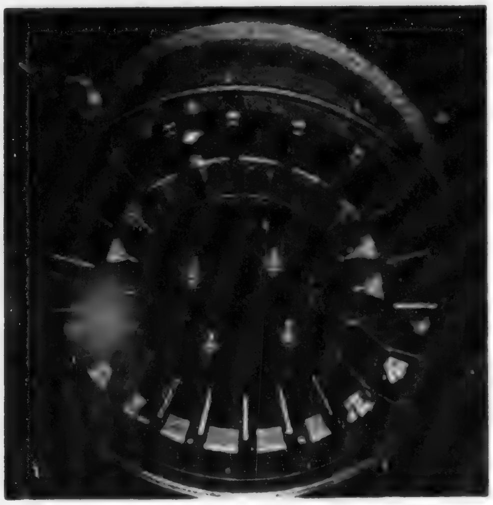
The drive train peripherals were lightened about 11.7 kg, particularly by use of an aluminum radiator. (Aluminium Pechiney file photo)



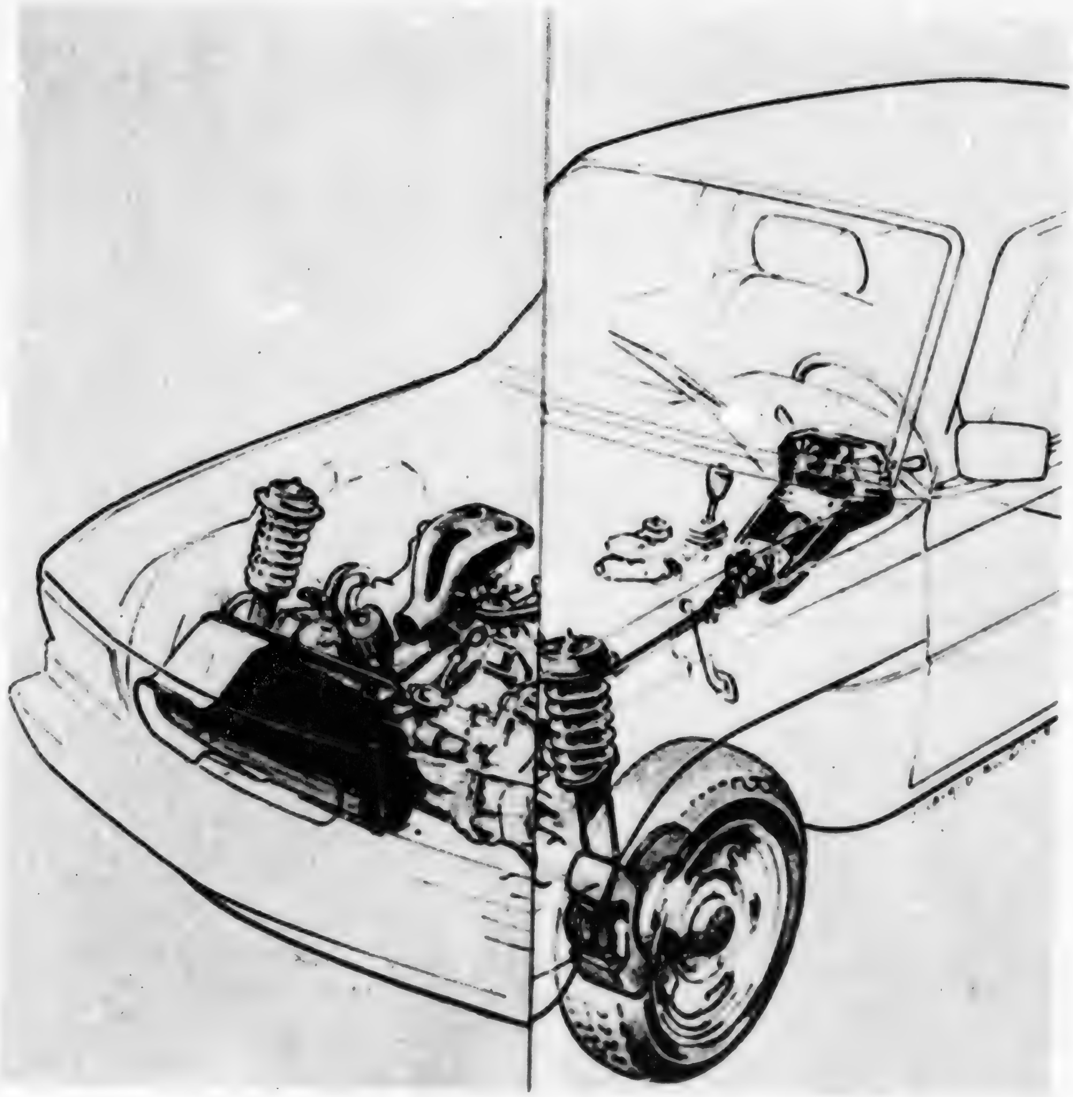
For the pedal cluster, the manufacturer also turned to synthetic materials. The pedals are made of aluminum tubes. (Peugeot file photo)



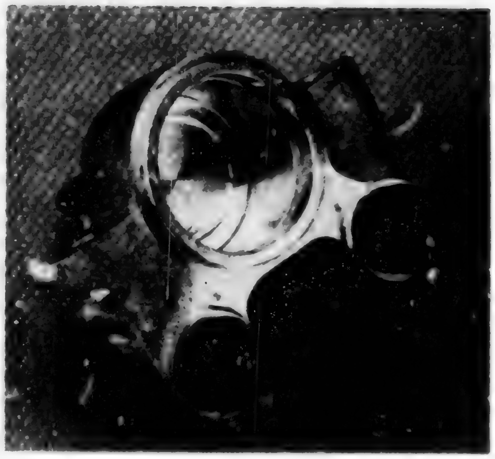
The front seat also is made with SMC. The framework of the seat is made of glass-fiber-filled polypropylene. The saving is about 1.4 kg. (Peugeot file photo)



Wheel rim traditionally made of sheet metal steel or of light alloy are today made of composite. The saving exceeds 1 kg. (Aluminium Pechiney file photo)



The mechanical parts of the Vera are also lightened: timing chain cover made of magnesium, rocker arm cover made of polyamide, exhaust manifold made of sheet metal. (In all, an additional saving of 3 kg.)



An old application revived: on the Vera, brake calipers made of aluminum. (Photo by Longchamp-Desmarteau)

The weight difference between the sheet metal of the door of the [Peugeot] 305, and the SMC (sheet molding compound) utilized on the Vera is 14 kg. (Peugeot file photo)

These changes are not taking place without problems. In Sochaux a limited series of 5,000 [Peugeot] 104's is being produced with a hood made of glass-fiber-reinforced polyester. In tests on the assembly line, it was found that a body without a hood (unprotected in the plastic version) would no longer pass through the electrophoresis tanks. The body was too light. It was necessary to devise a false hood which could be removed after the operation. Examples of this kind abound. One of the numerous problems to solve on the production lines will be the cohabitation of different materials with different resistances to temperature, impacts and chemical agents and different characteristics.

In addition to their insensitivity to corrosion and their lightness, the plastics offer other structural advantages. "In case of a frontal impact at 50 km/hour, one is in a better position with reinforced plastics than with steel." If the U.S. regulation for front-end impact without deformation at 8 km/hour is imposed in Europe (which may not manage to delay), cowls made with reinforced fibers [sic; more likely fiber-reinforced plastics] may become commonplace.

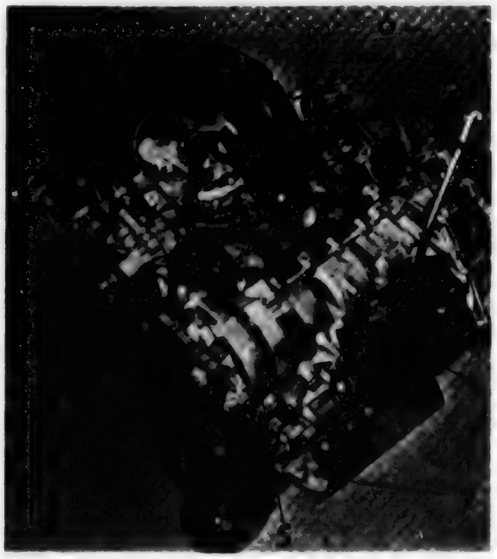
The plastic menace is now weighing more and more heavily on steel. After having practically filled the interior of the passenger space, the high-performance plastics in the future are going to gain ground in body parts. The first to make it around the cape will be the opening parts (hood, door, tailgate). Since the pioneering use of polyester for the roof of the [Citroen] DS (in 1955) the advances have come steadily. On the Vera, the door made of molded reinforced plastic SMC (sheet molding compound) weighs 7.4 kg against 11.2 kg in its sheet steel counterpart. The assembly in front of the cooling system of the [Citroen] GS made of composite weighs 2.5 kg against 3.75 kg. These are decisive advantages, all the more so as each kilogram saved on the body implies a supplementary saving of 0.4 kg in the support structures.

Some inconveniences remain, to be sure: the cost of the high-modulus fibers, the difficulties and risks of manufacture, the still insufficient production rates. However, at the bottom line, the balance remains favorable. The competition among the numerous suppliers leads to rapid improvements. G. Sifre is explicit in offering his views: "The Billion firm already has at its disposal a process for fabricating an underframe and a body in the automobile time setting. As for the starting materials, we have the necessary competence in France. There are just a few places where it is necessary to rethink the car." At Peugeot, developments have been pushed very far "for their own sake." A suspension arm made of carbon fiber and glass fiber embedded in resins has been realized by Citroen. The final weight of the part is about 1.4 kg, or nearly 50 percent less than its metal counterpart. This arm includes two U sections assembled by adhesive bonding. One is made of carbon fiber in an organic matrix, the other of glass fiber. The first absorbs flexural stresses, the second torsional stresses. The metal sleeve which receives the cylindrical knuckle is countersunk into an insert also made of resin. This project, realized in conjunction with SEP [European Propellant Company] (which fabricates the Ariane rocket engines) in St-Medard-en-Jalles (near Bordeaux), has benefited from a DGRST [General Delegation for Scientific and Technical Research] contract. The static tests show a satisfactory strength, and the fatigue tests are presently in progress at the Citroen Technical Center in Velizy. This very avant-garde solution is far from being industrializable at the present price of carbon fiber.

The ultimate example of the present technique: a suspension arm made with carbon fibers and glass fibers. It was developed by Peugeot, Citroen, and SEP. (SEP file photo)

At Renault, they are more circumspect: "The spring made of carbon fiber: it is not serious," they say at the Rueil Center for Studies (a limited series of 1981 Chevrolet Chevettes is equipped with a single-leaf suspension spring made of carbon fiber). "I do not believe that the plastic materials provide an answer," states a materials specialist. "Carbon fiber is too expensive, and it is not known how to cut Kevlar fiber, much less how to assemble these materials."

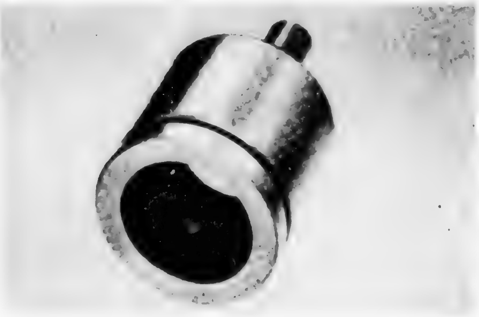
Like Peugeot, Renault has a series of lightened prototypes undergoing research. "Not much of a revolution [is expected] before 1985. Already 130 kg has been saved, and another 60 to 80 kg can be pared. The problem has been formulated, but one is still faced with blank pages." Despite an obligatory prudence, plastics are gaining ground slowly. Little by little the progression led to the rocker arm cover made of polyamide. A year from now, some plastic hoods will go into series production on a trial basis. The preoccupation with sales and with acceptance of the new changes by the buying public remains very much in evidence. "It is necessary to build light but not cheap. The public is used to a polished appearance. Will plastic in the body be very marketable?"



The engine of the [Peugeot] 104 includes a number of weight reduction features--magnesium carburetor, polyamide rocker arm cover, lightened engine flywheel, and so forth--nearly 5 kg in all. (Peugeot file photo)

In fact, and despite the experience with the Eve (on which the entire body was made of aluminum) they remain very "sheet metal" and very "cast metal" oriented at Renault. Of all the French manufacturers, Renault is the one which utilizes the least aliminum, another protagonist of choice in the fight against weight: 33 kg on the average per vehicle, as compared to 50 kg at Peugot and 54 kg at Citroen, according to data from Pechiney. The Renault 4 contains 15 kg of aluminum; the Citroen CX GTI contains 103 kg. It is true that the price of aluminum causes it to be reserved for use on upper echelon cars (150 kg on the Prosche 928, 110 kg on the Mercedes 450).

Despite its price and its high energy content, aluminum also holds an important card to play in the years to come. "The opportunity for aluminum is especially strong in molded parts," thinks J.-L. Mazodier of Pechiney. The penetration of this metal in France is already total or substantial for a number of motor components (100 percent of the cylinder heads and pistons, 44 percent of the engine blocks). According to the forecasts of PUK [Pechiney-Ugine-Kuhlmann], the average 1985 automobile should contain more than 45 kg of aluminum as compared to 40 kg at present. The first-generation applications (transmission cases, clutch housings, intake manifolds, and engine blocks) will continue to evolve rapidly. The second-generation applications (wheels, suspension arms, braking and steering components) got a later start and require higher performance alloys. The Calypso family responds to this need. There again, developments are inevitable in spite of the excess material cost.



Brake caliper pistons made of aluminum. A modest application which manages to save a few grams. (Aluminium Pechiney file photo)

Second-generation applications of aluminum now include mechanical elements such as the suspension arm of the Citroen CX. (Aluminium Pechiney file photo)

A safety part of prime importance, this tandem master cylinder is also made of aluminum alloy. These second-generation applications will continue to develop rapidly. (Photo by Longchamp-Desmarteau)

People are now talking about third-generation applications. This time, the goal is wearing parts (rings of synchronizers, cylinder liners). For that, the French producer is looking to powder metallurgy with Al-Si-graphite lubricant compositions. All these new applications are developing to the detriment of cast metal. "Above all, it is cast iron which will suffer," states Mazodier. The French foundrymen ought to change over to aluminum along the lines of the changes presently taking place in West Germany.

The outlets available in body components on the other hand are very limited. Despite the developments achieved already (the 5182 series satisfactorily accommodates great deformations in stamping), a mass-produced body made of aluminum is out of the question at the present time. Aside from the technical problems (soldering, painting), the automakers do not wish to bind themselves irrevocably to this metal. Production of aluminum is concentrated in the hands of six giants. Moreover, since its introduction on the London Metal Exchange in 1978, its price has become vulnerable to speculation (even though the volume of trades handled on the London exchange is still very limited). Finally, of all the materials available, aluminum has the highest energy content. At Peugeot they do not have too much faith in it. "As our company sees it, the energy balance is unfavorable."

A passage en masse from sheet steel to sheet aluminum in the automobile is nevertheless conceivable. For that to happen, it would be necessary to create new capacities for thin sheets, where present capacities are clearly insufficient. The Americans are thinking along those lines (in the United States the steel/aluminum price ratio is more favorable). The consequences for the iron and steel industry would be catastrophic.

Another technique which is being discussed more and more concerns the composite or mixed alloys such as aluminum-ABS [acrylonitrile-butadiene-styrene resin]. That material allies the strong points of the individual components; a lightweight sandwich material consisting of three thin sheets is obtained, a metal core 0.6 mm thick with two plastic sheets bonded on either side. The problem is precisely the bonding: it is not known how to complete the bonding quickly. It is also necessary for the expansion coefficients of the components to be compatible. The whole idea is considered unfortunate by the advocates of recycling, who advise against utilization of biconstituent materials of this type because recycling is complicated--if not impossible--and expensive.

Zinc and its alloys also have their role to play. Nevertheless, the producers of Zamak are becoming worried--enough so to have commissioned a comparative study of Zamak versus plastics carried out by ILZRO (International Lead and Zinc Research Organization). The latter supplied data on the mechanical properties of Zamak 3 in comparison to 17 reinforced or unreinforced plastic materials (polypropylenes, polyester, polycarbonate, nylon 6/6, ABS, etc.). Zamak's main advantage lies in its tensile strength and in its constancy with temperature over a range from -40°C to +80°C. It shows superiority in flexural strength, creep properties, and impact resistance under tension or in shear. The economic argument also works to the advantage of the zinc alloys molded under pressure. Their only handicap is that they are more dense--between four and eight times more dense--than the plastic materials.

Copper's position is still tranquil enough, for 5 years at least. The replacement of the wiring harnesses (1.5 km of cables on a Rolls-Royce) by a loop of two or three conductors equipped with electronic pick-offs (multiplexing) is for the moment beyond the reach of the auto industry. The economy of weight is nevertheless attractive. The present harnesses are rendered increasingly complicated--and thus increasingly heavy--by the multiplication of electrical functions (window regulators, rear window wipers, etc.). They often weigh more than 15 kg, but the cost of replacement [with multiplexing] is prohibitive. The first applications will take place on buses. While holding off on multiplexing, the auto industry is increasingly turning to aluminum conductors.

Glass is another item contributing substantial weight to today's cars: on average 3 percent of the weight of the vehicle, or about 30 kg. In the course of the last 20 years, the glass surface area increased by an average of 3 percent per year.

Efforts are in progress to replace it where possible with plastic materials (polycarbonates) and reduce the thickness, the only parameter available to play with. The thickness is presently about 4 mm. The strength of glass decreases as the inverse square of its thickness. Thus a 3-mm pane is approximately twice as fragile as a 4-mm pane. This increased fragility is a handicap both in fabrication and in assembly on the production line. Nonetheless, all glassmakers are offering solutions of this kind (2 mm thickness at Triplex) which sooner or later will find application. Replacement of glass by polycarbonates runs into a different obstacle: insufficient resistance to abrasion. This drawback still prevents use of this plastic on windshields (because of abrasion by windshield wipers under dry conditions). On the other hand, for the side windows, these materials will probably come into use very soon.

Magnesium is still keeping a low profile. Its penetration into the industry is linked to the ratio between its price and that of aluminum. If this ratio approaches 1 (presently it is on the order of 2) as certain observers believe, its uses should take off and amount to 0.7 to 1 percent (about 6 to 9 kg) of each automobile by 1985.

The comeback of steel has been long awaited. Today, it is barely taking form with the arrival of high-elastic-limit steels and high-strength steels. This situation was summarized by G. Hughes, vice-president of Ford Europe, in the course of the last IISI (International Iron and Steel Institute) congress in Madrid in October 1980: "If steel hopes to preserve its present position as a primary material for the automobile industry, it will be necessary that the new generation of high-strength steels be available, and the sooner the better...if the iron and steel industry does not do whatever is necessary to take up these challenges (the new materials), I have the feeling that there will only be one remaining solution: the automobile industry will find the means to adapt itself to some replacement materials." The warning, mainly intended for the European iron and steel industry, is clear and grave.

Today it is known how to make thin sheet metal with a high elastic limit and high strength. The research goal is twofold: render the cars safer in case of impact (better absorption of kinetic energy through deformation) and save weight by reducing the thickness of the sheets. At Renault, this saving has been estimated at about 50 kg for an existing vehicle. In the United States the utilization of a steel rated at 345 MPa leads to a saving on the order of 10 percent on the thickness of the sheet used for a door (0.71 mm instead of 0.83 mm) while maintaining the same strength. According to the prevailing norms, the types of sheet metal presently used have a strength of 340 MPa (max) and an elastic limit of 225 MPa (max), though the actual delivered products have distinctly lower values. Three principal routes are available for obtaining these conventional steels which have some characteristics of special steels.

First one can add a hardening alloying element (phosphorus, manganese, or silicon). These sheet metals are adapted to deep drawing operations. To maintain a satisfactory weldability, the strength is limited to 450 MPa. Next, one can add more of certain dispersoid elements (niobium, titanium, or vanadium). The strength then becomes very high (higher than 800 MPa), but at the expense of ductility. Finally, it is possible to obtain dual phase alloys by rapid cooling with formation of martensitic structure. While the first category is easy to fabricate with the existing means, the other two categories imperatively demand a continuous annealing operation which ensures optimum conditions in terms of economics and quality. Thus in effect there are three families of new steels with complementary properties for different uses.

It is precisely on the matter of continuous annealing that the European iron and steel industry shows the most unmistakable tardiness. This technology dates back to the beginning of the 1970's and was industrialized for the first time by Nippon Steel in 1972 under the name of CAPL (Continuous Annealing and Processing Line). Two installations are being set up in Europe and will be operational this year, one in Sweden (SSAB) and the other in Belgium (Sidmar). Each has a capacity of 500,000 tons/year. Cockerill also intends to equip itself for such operations, as does Hoesch. Not a single installation is being set up in France, nor is any planned.

In the beginning, continuous annealing was developed as a way to improve the productivity of the traditional annealing in coils. The operation, totalling integrated into the line for fabrication of thin sheet metals, takes place in a matter of about 10 minutes instead of several days, and takes place without interruption.

The Japanese (Nippon Steel and Nippon Kokan, respectively number 1 and number 5 in the world) now have a complete mastery of the process and not one installation in the world operates without their know-how and their licenses. They have also furnished samples of sheet metals from industrial installations to most of the automakers.

This delay in outfitting the French iron and steel industry in this sector is unsettling, more especially so as no solution seems forthcoming. "The auto industry is incapable of clearly specifying its intentions, and the iron and steel industry does not have the means to anticipate the needs," remarks one expert. The installations for annealing in coils are already operating at reduced capacity, and the iron and steel industry cannot make a commitment to continuous annealing unless the automakers assure it a market, which is not the case. Considering that several years are required to put equipment of this kind in place, if the French auto industry decides to use these new steels, it will first seek them where they are already available, thus risking accentuation of the imbalance. Once again, it seems that salvation can only come from the state. Again there will be a problem of scale to be solved. Will the eventual beneficiary (Fr 400 million) be Usinor or Sollac?

The time which goes by without decision is not in anyone's interest. Who tomorrow will supply or replace the 600 kg of sheet metal contained in each automobile? At any rate, it will be necessary to choose, and choose well, among a panoply continually being expanded with new or improved materials and increasingly specialized materials.

Eve, Vera, Plume, and the Rest

Peugot's Vera (Experimental Vehicle for Applied Research) uses the 305 model as a base. In comparison to the series-produced version, the weight saving according to the manufacturer's data is around 175 kg, and the average fuel consumption in urban driving is about 6.4 liters/100 km versus 8.4 liters/100 km. The Vera Plus is an improved version of this prototype. The Eco 2000 is a new undertaking for the automaker in conjunction with the government authorities. This will be a small vehicle intended for large-scale production (1,000/day). Its weight is to be on the order of 550 kg and the fuel consumption around 3 liters/100 km in urban driving. The car should go into production around 1990.

Renault's prototype Eve (Elements for an Economy Car) is based on the R 18 but weighs 100 kg less and has an average fuel consumption of 6.2 liters/100 km (against 8 liters/100 km for the series-produced R 18). The Plume (Light Prototype Using Less Energy) is also a project based on improvement of an existing vehicle. The Vesta (Economy Vehicle with Advanced Systems and Technologies) is a project with practically the same specifications as the Eco 2000 and ought to be clearly defined by 1985 and capable of being put in production by 1990.

The Boom in Composites

According to SNIAS [National Industrial Aerospace Company] the French market for composite materials should double between now and 1990. In the next 5 years the automotive applications for composites should increase 40 fold. Presently, the world market is on the order of 135,000 tons for composites based on glass fiber, 1,500 tons for aramid fibers (Kevlar), and 1,500 tons for carbon fibers. The proportion of fibers in relation to the matrix is between 30 and 40 percent.

This matrix can be organic (thermoset or elastomer), inorganic (carbon or ceramic), or even metallic (injected liquid light alloy). The last two categories are only employed in aeronautic or space applications (engine nozzles of the Ariane launch vehicle, fin of the Mirage 4000). At the present time, Japan supplies around 75 percent of the world production of carbon fibers. Two supplemental plants ought to be constructed in Edurope before 1985. Kevlar fiber is produced by Du Pont, which is considering construction of a production plant in Europe.

The Irresistible Rise of Plastics at Peugeot. The Eco 2000 Will Not Be Comparable in Size to the 305

		1980	1985	1990
	305	Vera	Vera Plus	Eco 2000
Total weight (kg)	925	750	700	550
Plastics (kg)	74	167	190	250
Composites (kg)	1	67		

Steels for All Tastes

The three processes for hardening steels offer variable ranges of strength, elongation, and ductility as a function of their chemical composition.

The first category of hardening using the solid solution effect (addition of silicon, manganese, or phosphorus) gives a substantial elongation close to 40 percent, a strength in the neighborhood of 500 N/mm^2, and a modest elastic limit (about 300 N/mm^2).

The second category of precipitation hardening (or formation of microalloys in which the dispersoid elements can be niobium, titanium, or vanadium) gives strengths higher than about 600 N/mm^2 and elongations of about 27 percent. The third category of hardening by transformation (or formation of dual phase alloys) gives the most extended range of utilization and in particular offers the best ductility for a given strength. These three families find different applications according to the intended purpose (for suitable deformation in case of impact, or for structural parts). They exhibit different surface states, which can pose visual problems of appearance and color.

Basic Characteristics of the Fibers for Composite Materials. Forty Times As Much 5 Years from Now.

	Density (rho) [kg/dm^3]	Breaking strength (R) [MPa]	R/rho	Modulus of elasticity (E) [MPa]	E/rho
Glass fiber (type E)	2.55	3,300	1,290	73,000	28,000
(type S)	2.49	4,400	1,760	87,000	34,900
Kevlar fiber (type 29)	1.44	2,700	1,870	60,000	41,500
(type 49)	1.45	2,600	1,790	130,000	72,500
Carbon fiber (high strength)	1.82	2,300	1,260	210,000	115,000
(high modulus)	1.87	2,100	1,130	350,000	187,000

The sheet metals used in the auto industry have thicknesses varying between 0.8 and 1 mm. A change to steels with high mechanical properties enables the thickness to be reduced by about 10 percent. This decrease will necessarily have to be accompanied by a more effective protection against corrosion. Most iron and steel makers already offer solutions of this kind (galvanization on one side, coating with a zinc-aluminum alloy). There is universal interest in limiting the protection layer to a minimum for economic reasons and to avoid contamination of the scrap at the time of recovery.

Pieces of a Puzzle

According to Ford Europe, three parameters intervene in the choice of a material: the density, the thickness equivalance, and the price. The density is favorable to unreinforced plastics (0.9 to 1.1 kg/dm^3) which have the advantage over reinforced plastics (1.4 to 2.3), magnesium alloys (1.8), aluminum alloys (2.787 to 2.8), zinc alloys (6.8), cast metal (7.1 to 7.7), and steel (7.82 to 7.87).

Comparing the thickness of material required for a given strength, steel takes the lead (0.9 mm), followed by aluminum (1.1 mm) and reinforced plastics (nylon/glass fiber: 1.3 mm). If the criterion used is the thickness required for a given rigidity, steel comes first (0.9 mm), followed by aluminum (1.3 mm) and the reinforced plastics (2.5 mm).

The 1980 prices favor steel ($600/ton) followed by zinc ($800/ton), aluminum ($1,800/ton), and plastics ($2,100/ton). The forecasts for 1985 indicate $900/ton for aluminum and $3,300/ton for plastics.

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AUTO MAKERS DISCUSS USE OF PLASTICS AT ANNUAL CONVENTION

Zurich CHEMISCHE RUNDSCHAU in German 13 May 81 pp 1, 2, 5

[Article by Dr of Engineering Heinz Peukert, Glottertal: "Frontiers of Plastics Applications in Automobile Manufacturing"]

[Text] On 23 and 24 March 1981 in Mannheim, about 950 experts from the automobile and plastics industries in Europe and overseas had gathered for the 1981 annual convention of the automobile manufacturers, arranged by the VDI [Association of German Engineers] Plastics Technology Society. The principal theme was "frontiers in plastics applications in automobile manufacturing in the 1980's." Because the altered situation in the energy and raw-material sector in the last decade has resulted in a noticeable effect on the use of plastics in vehicle construction.

Increasing demands for comfort and substantial safety requirements can be met economically only by the use of plastics in many cases, and when there are good chances for large-scale fabrication these plastics bring about a notable advance. It is true that in this connection only the use of thermoplastics has constantly expanded, for developmental, fabricating, and cost reasons. But the hopes for opening up a considerably broader basis of application for plastics in vehicle construction are being subdued by the price increases resulting from price rises for crude oil, problems in connection with introducing such parts to industrial-scale fabrication, or uneconomic production costs because the number of pieces produced is too small. Therefore the dominant theme in the papers read at the convention was not the comments about new developments, but rather questions of whether lightweight construction using plastics is realistic, whether energy savings are economically possible with plastics, or whether the step from technical feasibility to large-scale fabrication is the obstacle to an extensive use of plastics. In an associated exhibition, 24 firms showed mass-produced plastic molded articles for automobile manufacturing, and 8 automobile outfits demonstrated the sensible employment of plastics in various types of vehicles.

Subdued Hopes

In a comprehensive survey of the basic theme, H. Hablitzel argued that hopes for a rapid expansion in the use of plastics are not justified. Paramount in the selection of a material is the achieving of an optimal technical solution, with the following factors being of decisive importance: A technical advance, minimization of costs, optimization of components, and improvement of fabrication.

Moreover, for future developments special attention must be paid not only to a functional optimization of components but also to the principles of long-term usefulness, the recoverability of raw materials, the application of energy-saving techniques for producing and fabricating materials, as well as to the saving of energy in operating the vehicle. The new consideration of the raw-material and energy situation made the outlook for plastics seem to be that of promising materials which can be employed not only in the interior but on the exterior of vehicles as well, and which would have prospects for an application in areas where there is considerable mechanical stressing. In the case of the last-named applications, what is considered above all are glass-fiber reinforced polyesters, reinforced polyurethanes, and the use of carbon-fiber reinforcing, whose technical feasibility has already been demonstrated through numerous developments--entire car bodies and ensemble sections--although the breakthrough here has not yet been achieved. The employment of glass-fiber reinforced plastics (GFP) rose between 1975 and 1978 from 1.9 to 3.6 kilograms per vehicle. In 1979 and in the structurally high-strength sector, 8,000 tons of this material went to bumpers, a figure which corresponds to 54 percent of the total reinforced thermosetting plastics used in automobile manufacturing. The prerequisite for the employment of GFP molded articles does not lie in their development, but in preparing for and carrying out the associated large-scale fabrication.

Without a doubt, a further technical advance in the vehicle sector is being brought about by the use of reinforced polyurethane molded articles, which are fabricated by the RIM technique. With these, one can achieve not only notable weight reductions but also desirable technical improvements such as, among others, corrosion resistance and flexibility in the molded articles, non-susceptibility to shocks and blows, and thereby increased serviceability. However, before they can be used on a large scale the requirement about a cost optimization and fabrication opitimization must be satisfied first. On the other hand, because of their economical fabricating in large numbers of pieces, for thermoplastics the breakthrough in automobile manufacturing was already successful in the 1960's. Thus, for example, since 1978 it has been possible to achieve an average increase of about 4 kilograms of thermoplastics per vehicle through the increased employment of modified polypropylenes or thermoplastic ethylene-propylene-terpolymers (EPDM). Moreover, the use of other commercial thermoplastics is increasing continually. An example of this is the rear of the new VW Passat, with a bumper guard made of thermoplastic EDPM and a blow-molded spoiler made out of a thermoplastic (Figure 1). On the same vehicle the sturdily molded door panel is fabricated from sawdust-filled polypropylene (SFPP), which increases the proportion of plastics used by about 3 kilograms/vehicle. Generally speaking, it can be stated that for a number of plastic molded articles for use in automobile manufacturing, their development has moved far ahead of the fabrication capacity, and therefore the input of new technologies is taking place only haltingly.

On the one hand, the fabricating process is not yet able to guarantee the uniform quality which is required in vehicle manufacturing, and on the other hand the fabrication methods and their automation have not been perfected to such an extent that an economical fabrication exists as yet. The introduction of new plastics applications into production requires a great deal of time. In doing this, if competitiveness vis-a-vis other customary materials is to be preserved, then given the higher material costs component to be expected for molded plastic articles the fabrication costs must be lowered--that is, productivity must be raised through automation. Of course, here the complete fabrication of the subassemblies must be incorporated into this automation.

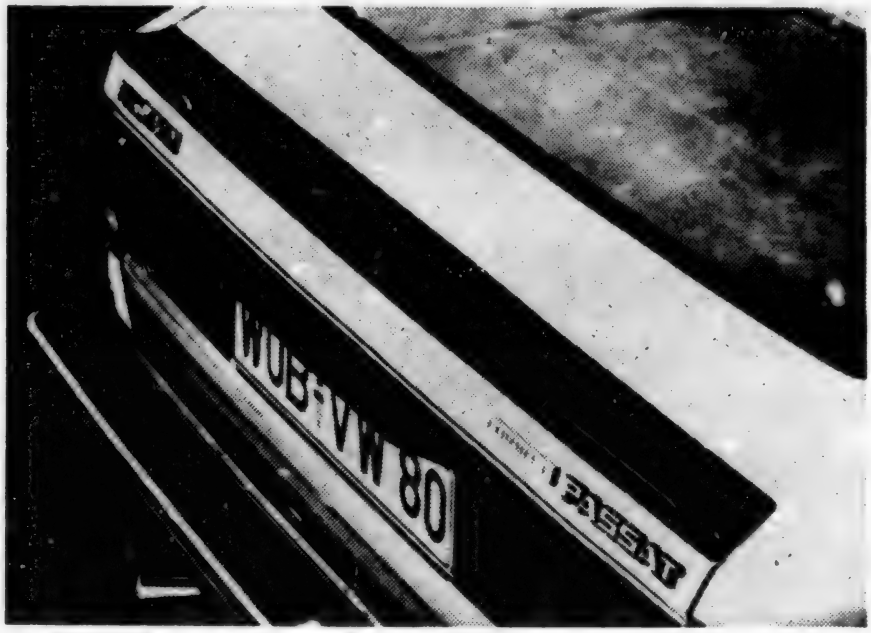


Figure 1. Spoiler Made From a Thermoplastic by Blow Molding. Absolute added weight: 0.685 kilograms/vehicle. By improving the c_w value, a saving of gasoline which corresponds to a weight reduction of the vehicle by about 23.5 kilograms.

Research and Production Associations

A highly developed automation and the associated substantial raising of productivity and economical fabrication has enabled the Japanese to press forward in automobile manufacturing (Figure 2). In the coming years, decisive efforts are in store for the automobile industry in this area--efforts which will require capital expenditures amounting to billions of marks. In order to keep the cost-intensive development of equipment for raising production within tolerable bounds for the individual vehicle manufacturers, European and American firms have teamed up to form research and production associations. Contacts have been entered into with Japanese businesses as well. Figure 3 shows the interlinking of the automobile concerns, with the objective of increasing efficiency and productivity through a linked and joint production.

These joint efforts for the purpose of raising productivity should be contemplated by the plastics industry as well. But various prerequisistes must be provided if these efforts are to materialize, such as a coordination between the large-scale chemical industry as the raw-material producer and the mostly small-scale industry which processes the plastics, and the modifying of the purchasing strategy of the vehicle manufacturers. Here also, rationalization measures for the sake of large-scale production will undoubtedly require considerable capital expenditures.

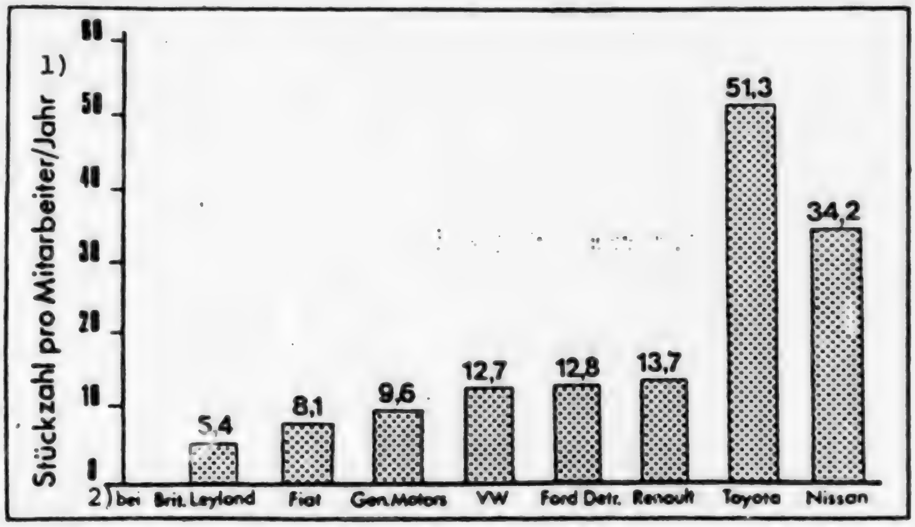


Figure 2. International Comparison of Production, 1979. Produced vehicles per employee and year for European, American, and Japanese automobile manufacturers.

Key: 1. Number of pieces per employee/year
2. At

According to K. D. Johnke, the trend toward lightweight construction in the automobile industry for non-load-bearing components is continuing to be realized by the use of plastics and suitable light metals. It is not yet easy to assess to what extent reinforced plastics are also replacing the customary materials in the sphere of highly stressable parts, especially since frequently new concepts and developments in automobile manufacturing are sparked by these new types of material. Because these composite plastics are associated with an elaborate automobile design and the resulting requirements for applications in vehicle manufacturing. In Europe, this plastics constituent lies between 40 and 100 kilograms per vehicle at present.

For fiber-reinforced composite plastics there are various matrix and reinforcing materials as well as diverse procedures available which can be selected and combined on the basis of designed loads and according to function. In this way the differing and to some extent even opposing criteria in the designing of a vehicle, as well as all legal requirements which are placed on a car body and on the exterior of vehicles, can be satisfied. But since the legal requirements are only general for the most part and not related to a specific material, the vehicle manufacturers should draw up uniform and suitable material specifications for the entire automobile industry based on practically oriented qualification profiles.

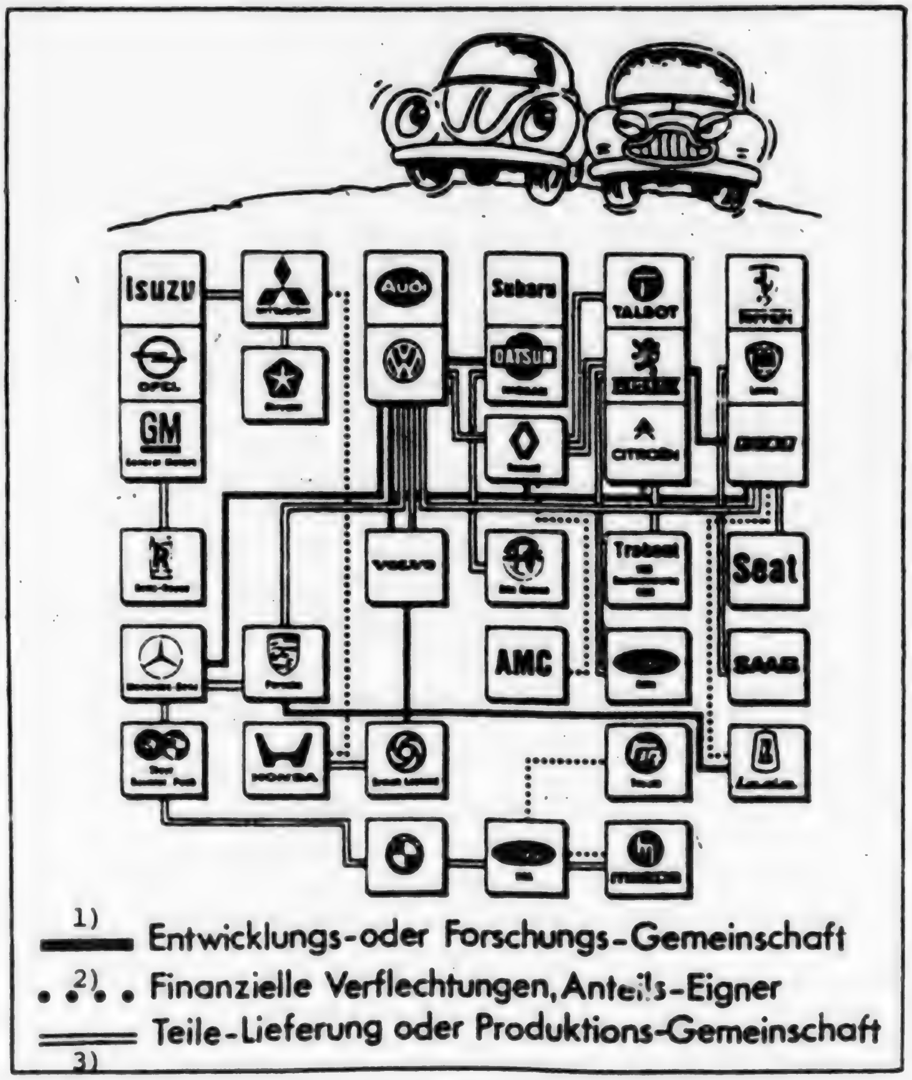

ISUZU
Audi
Subaru
TALBOT
OPEL
DATSUN
GM
CITROËN
Trabant
Seat
AMC
SAAB
HONDA
1)
Entwicklungs-oder Forschungs-Gemeinschaft
2)
Finanzielle Verflechtungen, Anteils-Eigner
Teile-Lieferung oder Produktions-Gemeinschaft
3)

Figure 3. Interlinking of the International Automobile Concerns

Key: 1. Development or research association
2. Financial links, shareholders
3. Parts supplying or production association

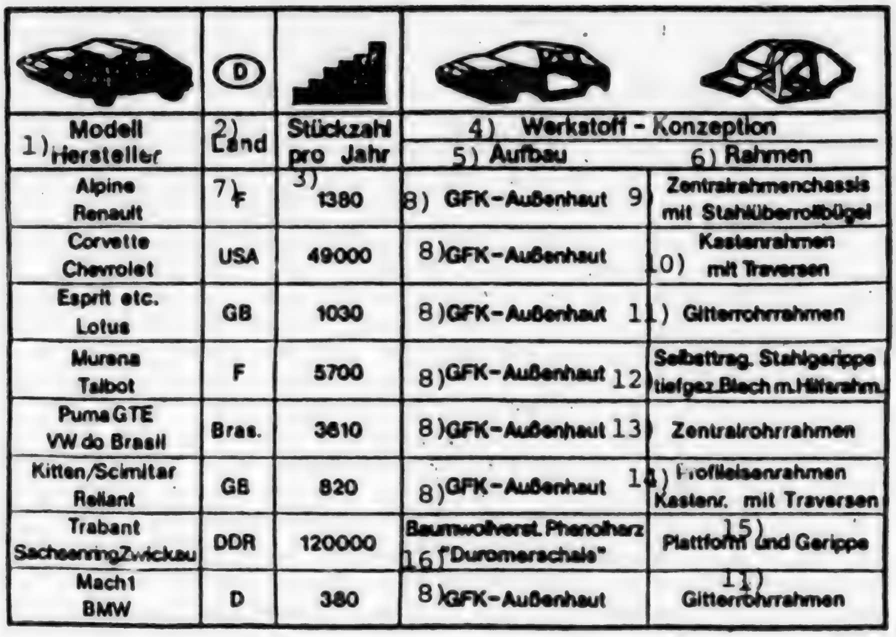
Competition Based on Substitutes

In the substitution competion against conventional, hitherto employed materials, the future development of prototypes will have to come to grips with technically feasible automobile parts made of fiber-reinforced composite plastics, such as leaf and spiral springs, frameworks, door side stabilizers, roll bars, and also chassis-unit parts, turbine rotors, or clutches. At the same time, the suitable process techniques for a large-scale production must be worked out. Furthermore, in this area consideration must be given not only to a functional optimization of components but also to the principles of a long-term maintenance of value of components, a capacity for recycling, and the use of energy-saving procedures in producing and fabricating the materials. An economical processing cycle is absolutely essential for a large-scale use of SMC [expansion unknown] types and resin-impregnated mats for functional molded articles in vehicle manufacture, with such a cycle extending from the program-controlled production of the initial material, past its manufacturing by mechanical processes, to the molding cycle and from there into the finishing and enameling stages. In this connection, the enameling of car-body components is still causing difficulties above all, since such an enameling must meet exacting visual standards in accordance with the inspection specifications of the automobile manufacturer and since it is measured by the standards for a sheet-metal enameling. In order to measure up to these standards, extensive developmental work is still necessary, because on the one hand it is difficult to produce GF-UP molded articles with a pore-free surface by the SMC process, and on the other hand even with the use of primers suitable to the material and a subsequent enameling, the pores are not completely closed and eliminated. But this means that considerable retouching work must be done, which involves corresponding costs. High polymers offer also manifold and often novel possibilities in the sector of noise control, whereby they furnish an effective contribution to environmental protection through sound insulation and absorption. A convincing example of this is the noise-screening jacket made of GFP for the diesel engine of the VW Passat, with an integrated recess for the horn, with which not only could the weight be lowered compared to the steel jacket, from 3.3 kilograms to 2.1 kilograms, but also the manufacturing costs could be reduced by 43 percent.

Plastic Car Bodies

The fabrication of complete plastic car bodies on an industrial scale will also continue to remain limited to prototype and small-scale manufacturing because the mechanization possibilities are too restricted and because of the additional space requirements for the curing process (Figure 4). Surely a quantity-produced complete plastic car body will continue to remain the exception.

However, for research purposes industry is continuously developing and testing extremely lightweight car bodies which help to save energy because of their small weight and low air resistance. With such developmental vehicles, a detailed insight is to be gained into the connections between the aerodynamics of an automobile, weight reduction, and fuel consumption. To what extent these developments have been advanced is shown by the results of the turbo-diesel vehicle C 111 of Daimler-Benz, and recently by the test runs of the ARVW (Aerodynamic Research Volkswagen). The demands placed on these vehicle car bodies could be satisfied only by a composite plastic with an extremely light and at the same time highly stressable laminated construction. This car-body shell, produced by the hand-laminating process, consists of a novel laminate construction, a combination of aluminum and fiber-reinforced UP resin, whereby on the one hand an optimal designing was achieved in accordance with aerodynamic principles, and on the other hand the desired stability was obtained with a wall thickness of only 1.8 millimeters--that is, by the lightweight construction method.



1) Modell Hersteller	2) Land	Stückzahl pro Jahr	4) Werkstoff - Konzeption	
			5) Aufbau	6) Rahmen
Alpine Renault	7) F	3) 1380	8) GFK-Außenhaut	9) Zentralrahmenchassis mit Stahlüberrollbügel
Corvette Chevrolet	USA	49000	8) GFK-Außenhaut	10) Kastenrahmen mit Traversen
Esprit etc. Lotus	GB	1030	8) GFK-Außenhaut	11) Gitterrohrrahmen
Murena Talbot	F	5700	8) GFK-Außenhaut	12) Selbsttrag. Stahlgerippe tiefgez.Blech m.Hilfsrahm.
Puma GTE VW do Brasil	Bras.	3610	8) GFK-Außenhaut	13) Zentralrohrrahmen
Kitten/Scimitar Reliant	GB	820	8) GFK-Außenhaut	14) Profileisenrahmen Kastenr. mit Traversen
Trabant SachsenringZwickau	DDR	120000	16) Baumwollverst. Phenolharz "Duromerschale"	15) Plattform und Gerippe
Mach1 BMW	D	380	8) GFK-Außenhaut	11) Gitterrohrrahmen

Figure 4. Plastic Car Bodies and Their Structural Design

Key:
1. Model, manufacturer
2. Country
3. Number of pieces per year
4. Material-design
5. Body
6. Frame
7. [in descending order:] France, United States, Great Britain, France, Brazil, Great Britain, GDR, FRG
8. GFP shell
9. Central-frame chassis with steel roll bars
10. Box frame with crossbeams
11. Tubular grid frame
12. Selfsupporting steel framework, deep-drawn metal sheeting with subframe
13. Central tubular frame
14. Sectional-iron frame, box frame with crossbeams
15. Platform and framework
16. Cotton-reinforced phenolic resin, "Duromer Shell"

In summary, it can be stated that both fiber-reinforced thermosetting plastics and fiber-reinforced thermoplastics are trend-setting materials with a logical utilization for automobile manufacturing, and that in particular SMC materials having a large or oriented fiber content will find new employment possibilities in vehicle construction.

Plastics Percentage Unsatisfactory

The increase in the plastics constituent in vehicle manufacturing is quite satisfactory, according to G. Walter; it reaches 7.3 percent in the new Mercedes-Benz passenger-car model series of the S class. In this connection, up to now four fifths of the plastics applications have been concentrated predominantly on the car interior, and only a limited amount has been used for car-body components. Occupying second place, on account of their pronounced electrical insulation properties, are plastics applications in the automobile electrical system. On the other hand, in the various units such as engine, chassis unit, and transmission, hitherto only few plastics parts have been used.

The employment of plastics as structural materials in automobile manufacturing was set forth by way of exhibiting various functional plastic parts, and the corresponding structural and material standards were explained. A general view of successful large-scale applications of plastics for functionally important components is given in Table 1. It is clear from this list that primarily high-grade, mostly fiber-reinforced thermoplastics and thermosetting plastics are being used. In this connection, as a rule new plastics are first introduced in passenger cars, and are then tried in utility vehicles after some large-scale trials under the most difficult of conditions. It is assumed that for an intermediate-sized van the plastics use is about 80 kilograms on the average, and for a 40-seater bus it is about 280 kilograms because of the large area devoted to interior accommodations. Another functional component which because of its pattern of properties contributes considerably to functional safety and a long service life is the cooling fan. The prospects and developmental emphases for further applications of plastics are listed in Table 2. According to this, fiber-reinforced, force-distributing, fracture-resistant, and cushioning plastics are coming into use above all. Here, the fiber-reinforced plastics are at the center of interest for use as mechanically and thermally highly-stressed plastic parts. But in order for numerous new possibilities to be opened to them as structural materials, the development of production methods and component designing and testing in interaction with all the different testing mechanisms is needed to reach the stage of mass production. Aside from these technical difficulties, the industry is still faced with not very encouraging economic prospects with respect to price developments. Therefore the introduction of further applications of plastics to quantity production in the vehicle industry continues to require a great deal of commitment and consciousness of the problems involved.

Aircraft Manufacturing

D. Schutz provided a glance on the other side of the fence with his comments on the application of fiber-reinforced plastics in civilian aircraft manufacture. The use of these composite plastics is mainly for the purpose of reducing structural weight and thereby saving on fuel costs in connection with modern passenger aircraft. Starting from more than 15 years of experience with the employment of conventional glass-fiber reinforced plastics (GFP) and a fundamental technological knowledge in the areas of the design and fabrication of modern fiber composites, from 1976 on the development of weight-saving secondary components from modern fiber composites was undertaken in connection with the redesigning of the smaller Airbus A 310. Aramide-fiber reinforced (SFP) and carbon-fiber reinforced (CFP) plastics as well as their hybrid are being processed in connection with the fabricating of spoilers, rudders, nose parts, landing-gear flaps, and fairing parts. The employment of these rigid, high-strength composite plastics allows a weight reduction of about 20 percent compared to the conventional lightweight-metal components. After several years of successful operational testing, these components are to be used in quantity from 1983 on. The manufacturing of the first Airbus rudder out of carbon-fiber reinforced plastics represents another basic developmental step. This moveable tail-assembly part, which is 8.3 meters high, is constructed according to the sandwich-panel design, since by this means it could conform best to the design specifications. To be sure, this structural design does not allow the maximum weight reduction, but it does allow instead a more cost-favorable fabrication. This rudder, which is currently the largest CFP aircraft component in Europe, is now starting to be operationally tested on an Airbus of Deutsche Lufthansa. With that, MBB [Messerschmitt-Boelkow-Blohm GmbH] has come considerably closer to the goal of having the capacity, by the middle of the 1980's, to fabricate the entire Airbus rudder unit, currently weighing just under 1.2 tons, out of modern fiber composites, which will make it about 20 percent lighter and more economical. This rudder unit, as the first fiber component of a primary structure for the Airbus, will thus take on a fundamental significance for civilian aircraft manufacturing. Because in the last analysis the information on construction, fabrication, and quality gained in the redesigning of the rudder was responsible for the fact that the development of the load-bearing rudder-unit body was undertaken with fiber composites. Such a component is to be delivered to Deutsche Lufthansa for putting into commission by 1985. By the example of this intermediate rudder-unit body, ultimately the proof is to be furnished that the use of modern composite plastics for load-bearing aircraft structures is a suitable step for lowering operational costs without endangering safety.

Through continuous research and development in the area of fiber-composites technology, it is expected that by the year 2000 fiber composites will be used as the primary material for almost all structural components of the passenger aircraft. In doing this, the result for an airplane of the size of the A 310 would be a reduction in mass of about 6,000 kilograms. Given the present cost and price situation and for an airline with a fleet of 20 aircraft of this type, this would lead to an annual cost savings of about DM 45 million.

Table 1. Large-scale Plastics Applications With Functionally Important Components. (+): Application limited to single types or to an initial mass-production phase.

		Application with		
Component	Plastics used	Car	Van	Bus
Hood	Polyester GFP (UP-GF)	-	Unimog	-
Bumper supports	UP-GF	(+)	-	-
Distributor cap Distributor rotor Spark-plug terminal	Polyester molded material	+	-	-
Fan for the radiator	Polyamide 6/glass-fiber reinforced (PA 6 GF)	(+)	(+)	-
Radiator tank	PA 66 GF	+	(+)	-
Bearing cages	PA 66 or PA 66 GF	+	+	+
Suspension frame, electrical system	PA GF or polycarbonate GF	+	+	+
Wheel shield	PA 6 GF enameled	+		
Slide rails for camshaft chain	PA 66, heat-stabilized	+	-	-
Tubes for compressed air, fuel, oil, suction	Polyamide 11, 12 (6)	+	+	(+)
Radiator grill	Polyamide, polypropylene ABS, glass-fiber reinforced	+	+	-
Fan cowls	Polypropylene, talcum-filled	+	+	-
Air ducts, tubes, hoses	Polypropylene, polyethylene hard (PE)	+	+	+
Cooling-water header tank	Polypropylene (PP)	+	+	+
Accelerator pedal with integrated film hinge	Polypropylene	+	+	+
Bushings and the like	Polyacetal (POM), polyurethane	+	+	+
Fuel tank	Special polyethylene, hard	(+)	(+)	-
Gaskets in the power steering, automatic transmission	Polytetrafluor ethylene (PTFE) compounds	+	+	+
Operating handles	POM, PA, PP, PE, ABS	+	+	+

Table 2. Developmental Emphases of Further Plastics Applications

Goal	Aimed at by using
Weight reduction	Fiber-reinforced plastics for car body and functional components (in addition to other lightweight construction materials)
Safety	Cushioning, force-distributing, and fracture-resistant plastics
Economy	Materials/components with favorable total costs (price of materials, manufacturing, installation)
Noise deadening	Materials which contribute to the reduction of noise generation and radiation
Alternative fuels	Materials which are unaffected by alternative and conventional fuels
Comfort/styling	Materials which correspond to demands specific to particular vehicles

RRIM Technology

In the opinion of D. F. Gentle, in the near future most of the innovations in the area of plastics applications in automobile manufacturing will occur in the field of RRIM technology, where not only polyurethanes but also non-polyurethanes will come into use. In the United States, for the RRIM technology the PUR [polyurethane] materials are divided into four groups on the basis of their typical [elastic] modulus ranges, which in turn have ranges for unreinforced and reinforced material (Table 3). But in order to be able to introduce an optimal material for RRIM exterior parts, extremely intensive developmental work is still needed both on the material itself and on the material treatment and the fabrication process. Among other things, RIM materials must be developed which combine a high dimensional stability at 204°C with good impact-strength properties and which provide molded articles which are free of sink marks. Moreover, fabrication techniques must be developed which allow the fixation of the fiber mats in the mold cavity during the injection of the RIM material at the prescribed place.

Table 3. Designations and Classification of RIM and RRIM Materials.

	Material designation	Reinforcing additive %	Typical flexure elastic [E] modulus range N/mm^2	Sample thickness mm	Specific-weight range kg/m^3	Typical applications
A	RIM with low E-modulus	-	35-350	≤ 3.2	870	Dashboard
B	RIM reinforced, with low E-modulus	5-30	70-560	≤ 3.2	950-1135	Dashboard
A	RIM quick-acting, with intermediate E-modulus	-	35-490	≤ 3.2	870	Undecided
B	RIM quick-acting, reinforced, with intermediate E-modulus	5-30	700-980	≤ 3.2	950-1135	Fender, fender reinforcements, spoilers
A	RIM with high E-modulus	-	700-2450	≤ 3.2	870	
B	RIM reinforced, with high E-modulus	5-30	1400-5250	≤ 3.2	950-1135	Fender, trunk, hood
A	RIM, hard (structural fomed plastics)	-	420-840	≤12.7	420-560	Undecided
B	RIM, hard, reinforced	5-30	480-1680	≤12.7	630-930	Hood, trunk lid
	RIM made of non-polyurethane		Values are to be determined according to the availability of these materials			

In the course of the convention it was emphasized several times that the reducing of the c_W value--that is, the designing of the outer shape of the automobile--is of decisive importance to a saving of energy in operating the vehicle. Using the example of the Medusa, a sporty sedan with an intermediate-sized engine and with the mechanics of the Lancia Beta Montecarlo (Figure 5), with a c_W value of only 0.263, H. Giugiaro made various noteworthy suggestions. He stressed in his commentary on this that a number of these requirements for a c_W-value reduction can be realized economically only by using plastics.

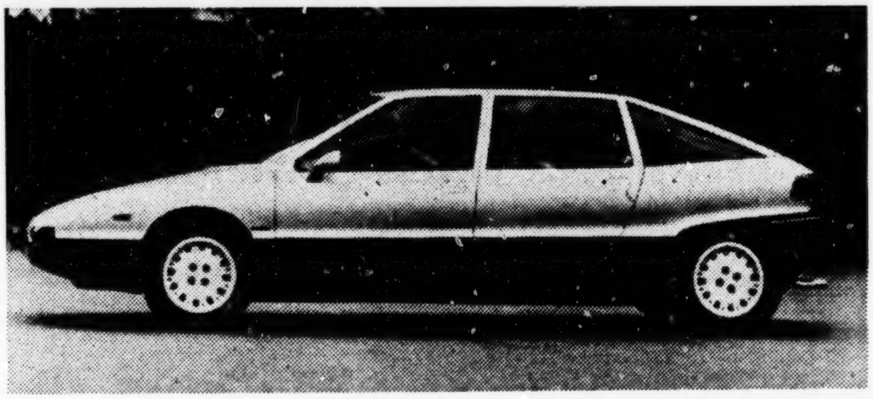


Figure 5. Medusa (prototype) of Italian Design. Sporty sedan developed according to aerodynamic criteria.

In other papers, the employment of plastics for various components was discussed, and moreover expression was given to the view that the range of plastics available today offers such manifold possibilities that with a selective choice of material the safety and performance regulations as well as the economic requirements can be satisfied. Moreover, the development of new process techniques also will allow a mass production of exterior parts.

The lively, to some extent even controversial discussion revealed once more the relevance of the topics chosen, but at the same time made it clear also that an important role falls to plastics as structural materials in the task of fulfilling the future requirements of automobile manufacturing. But it also showed that extensive developmental work is still necessary in order to satisfy the demands which will be placed on these materials. Here, the fabrication technology takes on a primary importance as well, since it must be integrated in a trouble-free way into the large-scale production of the vehicle industry. It was stressed again and again at the convention that all these problems can be solved only through a close and concerted cooperation between the plastics and automobile industries.

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BRIEFS

METHANOL BUS IN BERLIN--In Berlin the MAN AG (Augsburg) has handed over a city bus with an alcohol-powered engine for use in regular service. It is the first bus from MAN which can be run on pure, undiluted alcohol. Assurances are given that the engine is as economical in consumption as a diesel, gives off only extremely "low levels of toxic emissions and operates completely soot-free." It is based on an already proven six-cylinder MAN diesel, but is equipped with an additional ignition system and a modified combustion chamber. Ignition takes place by means of spark plugs. For compression ignition the compression ratio would have had to be raised so high that the components would have been mechanically overstressed. As a result of the ancillary ignition system the compression ratio remains the same as in the diesel engine. The typical diesel cold-starting problems are absent, and preheating devices are not needed, in the company's opinion. However, the volume of the fuel tank had to be doubled in order to achieve about the same operating range as with a diesel motor; methanol attains only just half the figure of a diesel. In the view of MAN, methanol, which can be derived chemically from coal and natural gas, is close to being economical, in view of rapidly climbing fuel prices. [Text] [Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 23 Jul 81 p 7] 9581

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